Statistical analysis of cosmic microwave background data

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The Cosmic Microwave Background (CMB) consists of photons that began to travel freely when the Universe was approximately 379000 years old. The CMB is completely characterised by its intensity tensor. A CMB detector measures the CMB's intensity tensor P that depends on the direction of observations, $\mathbf{n}$. Mathematically, $\mathbf{n}$ is a point on the sphere S^2, while $P(\mathbf{n})$ is a section of the special tensor bundle over S^2, namely, the tensor product $TS^2 \otimes T^*S^2$ of the tangent bundle TS^2 by the cotangent bundle T^*S^2.

In cosmological models, it is usually assumed that the CMB is a single realisation of a random field. In other words, $P(\mathbf{n})$ is a random section of the bundle $TS^2 \otimes T^*S^2$. A variant of the rigourous mathematical theory of random sections of vector and tensor bundles was built by Malyarenko [1].

After performing primary statistical analysis of raw CMB data we obtain a pixel map $P(\mathbf{n}_j)$. The next step is to perform statistical tests in order to accept or reject the following standard cosmological hypothesis:

$P(\mathbf{n})$ is an isotropic Gaussian random field.

Until now, almost all performed tests used only a part of information that contains in the intensity tensor, namely, its trace, the total intensity $I(\mathbf{n}_j)$.

In our presentation, we will discuss how to use the complete intensity tensor map in the statistical tests.

References

[1] Malyarenko, A. (2011). Invariant random fields in vector bundles and application to cosmology. *Annales de l'Institut Henri Poincaré* (in press).